

Nutrient Foramen of Fibula in relation to distal end, potential implications for vascularised bone graft surgery

Article (Published Version)

Bhatti, Amjad N and Smith, C (2019) Nutrient Foramen of Fibula in relation to distal end, potential implications for vascularised bone graft surgery. *International Journal of Human Anatomy*, 1 (4). pp. 29-32. ISSN 2577-2279

This version is available from Sussex Research Online: <http://sro.sussex.ac.uk/id/eprint/88662/>

This document is made available in accordance with publisher policies and may differ from the published version or from the version of record. If you wish to cite this item you are advised to consult the publisher's version. Please see the URL above for details on accessing the published version.

Copyright and reuse:

Sussex Research Online is a digital repository of the research output of the University.

Copyright and all moral rights to the version of the paper presented here belong to the individual author(s) and/or other copyright owners. To the extent reasonable and practicable, the material made available in SRO has been checked for eligibility before being made available.

Copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

Nutrient Foramen of Fibula in Relation to Distal end, Potential Implications for Vascularised Bone Graft Surgery

Amjad N Bhatti^{1,*}, C Smith¹

¹Brighton & Sussex Medical School, BN1 9PX

Abstract

Background

Free vascularised fibular bone grafting has gained popularity in various Orthopaedic and Oral & maxillofacial reconstructive surgeries. The objective of the present study was to identify the morphology and topography of nutrient foramina of fibula and to determine the foraminal index (FI) of the fibula using a more surgeon friendly bony landmark.

Methods

The study comprised examination of 100 fibulae specimens. Each bone was divided into 03 parts and topographical analysis was performed on each section. The nutrient foramina were identified macroscopically using size 24-gauge needle. Modified Hughes formula was used to calculate the foraminal index using distance of foramen (DF) from distal end which is easier to palpate in living human beings, total length of fibula (TL); and the formula was $DF/TL \times 100$.

Results

With respect to fibulae, 98% had single foramen and foramen was absent in 2%. The mean foraminal index (FI) was 56% for fibulae using modified Hughes' formula. The majority of the fibulae showed nutrient foramen in the middle 3rd in relation to distal end of fibula.

Conclusion

The study provides information on the morphology of nutrient foramina in relation to easily palpable landmark on living human beings, which can provide guidance to surgeon while performing microvascular bone transfer procedures.

Corresponding Author: Amjad N Bhatti, Brighton & Sussex Medical School, BN1 9PX, Email: amjad-bhatti@live.com

Keywords: Anatomy; Fibula; Nutrient Foramen; Foraminal index

Received: Sep 30, 2019

Accepted: Oct 18, 2019

Published: Oct 21, 2019

Editor: Abdelmonem Awad Mustafa Hegazy, Professor and Former Chairman of Anatomy and Embryology Department, Faculty of Medicine, Zagazig University, Egypt.

Introduction

Vascularised bone grafting has become a treatment of choice in various reconstructive surgeries [1-4]. Knowledge of Anatomy of nutrient arterial blood supply to fibula is important for surgeon as it provides a useful adjunct in preoperative and intraoperative assessment to avoid potentially disastrous ischaemic complications after harvest of the flap. Clinical examination is often supplemented by other investigations. Postal survey results show most of surgeons relying on preoperative clinical examination with colour flow doppler in the initial assessment of lower limb's vascularity followed by some kind of imaging studies [5].

The relatively invasive CT Angiography has the advantage of showing vascular anatomy but incidence of contrast allergy and nephrotoxicity are the associated risks. Magnetic resonance (MR) angiography has become increasingly popular and has the advantage of being non-invasive with comparable accuracy [5], however its availability in peripheral hospitals plus increased costs are limiting factors.

There is relative paucity of literature as respect to exact morphology and topography of diaphysial nutrient foramina in fibula. A literature search on Pubmed was carried out by Boolean method combining the terms 'Diaphysial' and 'nutrient foramen' and 'Fibula' which revealed only few such studies [6-10]. In almost all these studies the nutrient foramen was calculated using proximal end of femur as reference point.

The aim of this review is to equip surgeon with back ground anatomical knowledge which is beneficial while operating for vascularised fibular bone graft considering a more easily palpable bony landmark during surgery.

Material and Methods

100 bone specimens were studied at our institute and King's college London Institute; a size 24-gauge needle was used to macroscopically identify nutrient foramen. In our study we calculated the foraminal index (FI) taking lower end of fibula or lateral malleolus as reference point (Fig. 1). The reason for using distal end of fibula instead of proximal end is due to the fact of increasing level of obesity in these patients and potential difficulty encountered by surgeon due to

various body habitus factors [11]. The distal end is easier to palpate in living human beings as it is more prominent and mainly subcutaneous.

Results

Out of 100 bone specimens studied, 98 showed definite nutrient foramen confirmed by needle insertion, 02 bones did not show the nutrient foramen. The reason could be ossification, due to lack of availability of forensic data for these specimens we are not sure about the exact age of these bone specimens. The mean total length of fibular specimens was found to be 35.41 cm, mean foraminal distance from distal end of fibula was 19.69 cm with mean Foraminal index (FI) using modified Hughe's formula $FI = DF/TL \times 100$ (DF stands for distance of nutrient foramen from distal end and TL stands for total length) was 56% with standard deviation of 0.071.

Discussion

The fibula is supplied from one or more branches of the peroneal artery. In the present study, we observed the single fibular foramen in 98% of the cases, which is similar to the reports of Zahid et al [6], Campos et al [12] and McKee et al [13].

In study by Zahid et al [6], 85 bones (96.6%) of right side and 79 bones (98.8%) of left side had a single nutrient foramen. Mean foramen index was 47.6 for left and 50.2 on the right side. In the Korean study by Choi et al [14], the location of the nutrient foramen was found to be just proximal to the midpoint. The study by Kocabiyyik et al [8] also found most nutrient arteries were near the middle third of the fibula. In study by Gumusburun et al [10], the common location for nutrient artery foramen is middle third of fibula 98.0 %. The mean foraminal index of the fibula was found to be 48.14 %. Campos et al [12] studied the nutrient foramina of both upper and lower limb long bones in Spanish specimens and found that in the fibula the nutrient foramen index is between 35 and 67 %. According to the Turkish study from Kizilkanat et al [9], foramina were located on the diaphysis and calculated Foraminal index between 26–83% for the fibula. In the present study, it was observed that the foramina were located on the diaphysis. The majority (90%) of the fibular specimens, foramina were located at the middle 3rd of fibula. These findings are almost similar to the

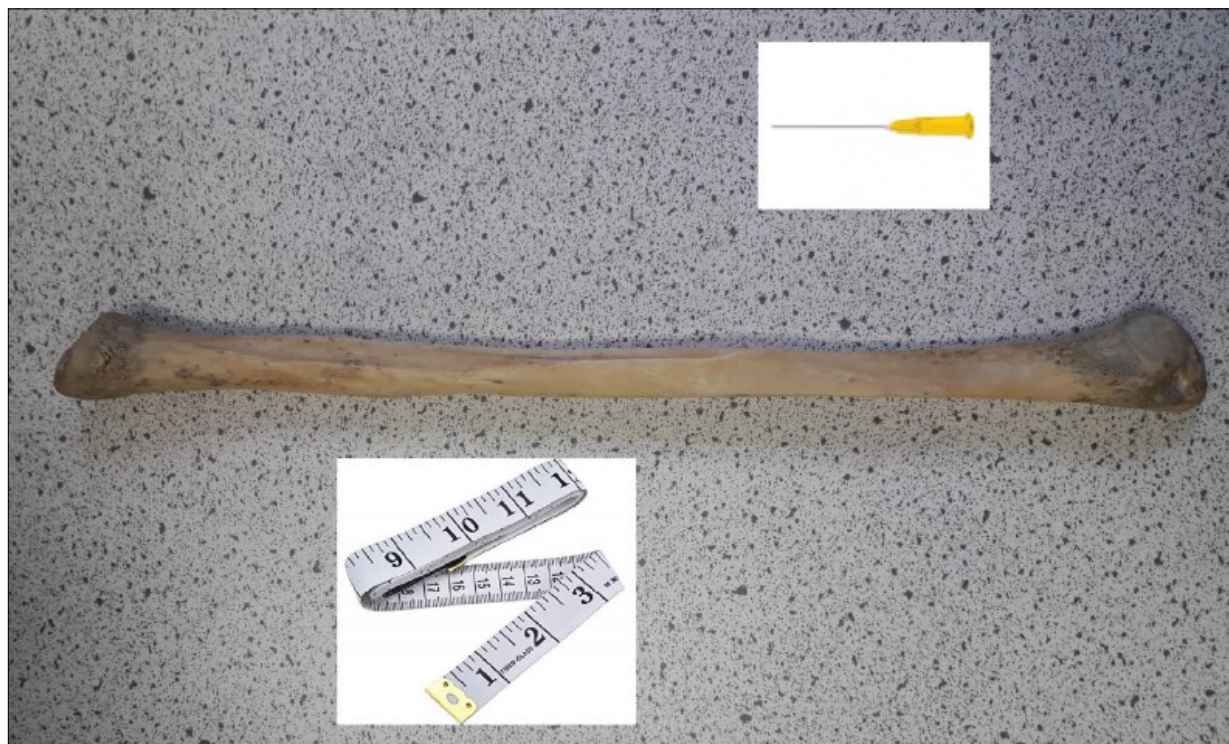


Figure 1. A fibula specimen and materials used in methods

previous reports from other studies; however, these mentioned studies calculated the foraminal index using proximal end of fibula as reference point.

The absence of nutrient foramina in long bones is well known [7,8]. It was reported that in instances where the nutrient foramen is absent, the bone is likely to be supplied by periosteal arteries. In the present study, the nutrient foramen was absent in 02 bone specimens however due to lack of availability of forensic data we are not sure if it represents age related ossification.

Our study has some potential limitations. These include age and sex differences which were not considered as we were not able to estimate the age and gender of the bones studied. The present study could not address these factors as the study involved cadaver dry bones without availability of forensic data. These differences might alter the results as the anatomy of foramina might differ according to gender and age.

Conclusion

The present study provides valuable information on the fibular bone nutrient artery foramina using an easily palpable bony landmark. As techniques such as microvascular bone transfer are becoming more popular,

information relating to the anatomical description of these foramina is vital to preserve the circulation of affected bony structures. Use of a bony land mark which is easily palpable during surgery could be helpful for surgeon.

Conflict of Interest

Authors declare no conflict of interest in preparation and submission of this manuscript.

Acknowledgment

Authors would like to acknowledge the contributions of Lydia Carline Anatomy Prosector at Brighton & Sussex Medical School and Kirsty Massetti at Kings College London for their valuable support in providing access to Fibular bone specimens.

References

1. Yamamoto N, Morikawa T, Yakushiji T, Shibahara T. Mandibular Reconstruction with Free Vascularized Fibular Graft. The Bulletin of Tokyo Dental College. 2018;59(4):299-311.
2. Liu S, Tao S, Tan J, Hu X, Liu H, Li Z. Long-term follow-up of fibular graft for the reconstruction of bone defects. Medicine (Baltimore). 2018;97(40):e12605-e.

3. Makiguchi T, Yokoo S, Hashikawa K, Miyazaki H, Terashi H. Evaluation of bone height of the free fibula flap in mandible reconstruction. *J Craniofac Surg.* 2015;26(3):673-6.
4. Matsuura M, Ohno K, Michi K, Egawa K, Takiguchi R. Clinicoanatomic examination of the fibula: anatomic basis for dental implant placement. *Int J Oral Maxillofac Implants.* 1999;14(6):879-84.
5. Whitley SP, Sandhu S, Cardozo A. Preoperative vascular assessment of the lower limb for harvest of a fibular flap: the views of vascular surgeons in the United Kingdom. *British Journal of Oral and Maxillofacial Surgery.* 2004;42(4):307-10.
6. Zahid A, Shakir MA, Shireen R. Morphological and Topographical Anatomy of Diaphyseal Nutrient Foramina of Dried Pakistani Fibulae. *Journal of the College of Physicians and Surgeons--Pakistan: JCPSP.* 2015;25(8):560-3.
7. Murlimanju B, Prashanth K, Prabhu LV, Chettiar GK, Pai MM, Dhananjaya K. Morphological and topographical anatomy of nutrient foramina in the lower limb long bones and its clinical importance. *The Australasian medical journal.* 2011;4(10):530-7.
8. Kocabiyik N, Yalcin B, Ozan H. Variations of the nutrient artery of the fibula. *Clin Anat.* 2007;20(4):440-3.
9. Kizilkanat E, Boyan N, Ozsahin ET, Soames R, Oguz O. Location, number and clinical significance of nutrient foramina in human long bones. *Annals of anatomy = Anatomischer Anzeiger : official organ of the Anatomische Gesellschaft.* 2007;189(1):87-95.
10. Gumusburun E, Adiguzel E, Erdil H, Ozkan Y, Gulec E. A study of the nutrient foramina in the shaft of the fibula. *Okajimas folia anatomica Japonica.* 1996;73(2-3):125-7.
11. Wang YC, McPherson K, Marsh T, Gortmaker SL, Brown M. Health and economic burden of the projected obesity trends in the USA and the UK. *The Lancet.* 2011;378(9793):815-25.
12. Campos FF, Pellico LG, Alias MG, Fernandez-Valencia R. A study of the nutrient foramina in human long bones. *Surgical and Radiologic Anatomy.* 1987;9(3):251-5.
13. McKee NH, Haw P, Vettese T. Anatomic study of the nutrient foramen in the shaft of the fibula. *Clin Orthop Relat Res.* 1984(184):141-4.
14. Choi SW, Kim HJ, Koh KS, Chung IH, Cha IH. Topographical anatomy of the fibula and peroneal artery in Koreans. *Int J Oral Maxillofac Surg.* 2001;30(4):329-32.